Modeling UHPC Link Slabs for the Wilmington Viaduct Bridge Rehabilitation Project

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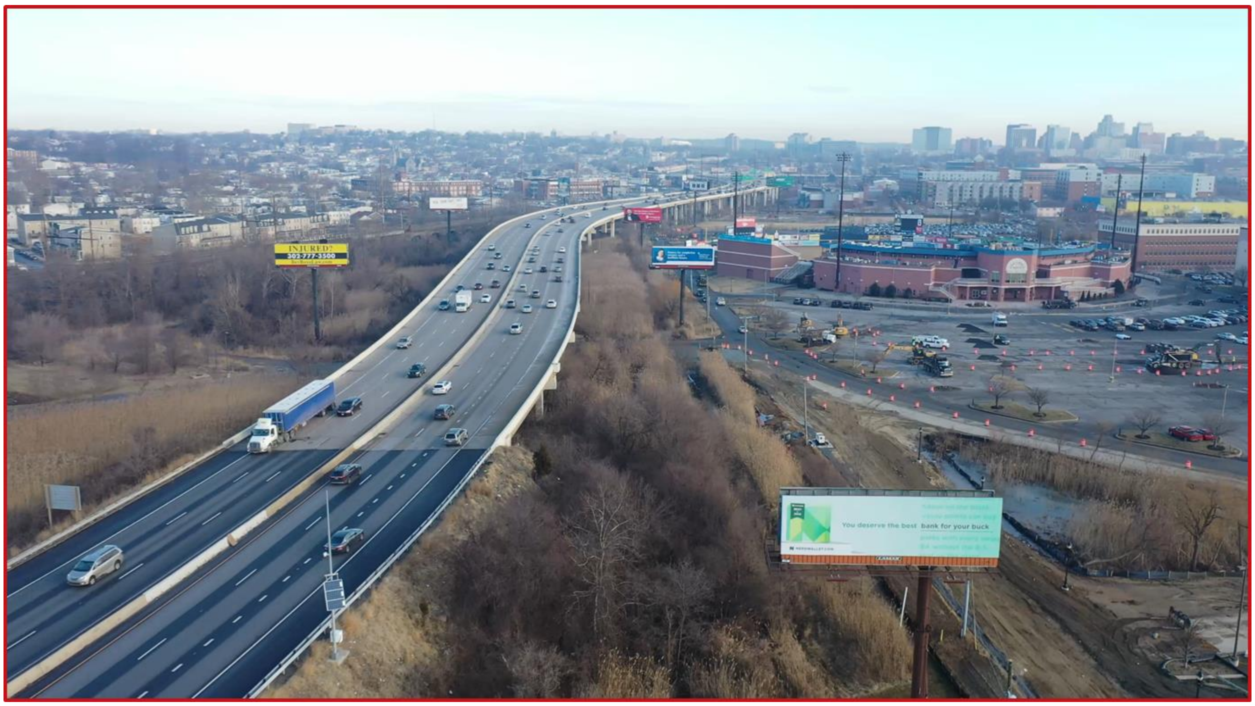
INTRODUCTION

The presence of open joints in modern bridge construction causes deterioration of substructure units as well as substantial maintenance problems at the bearings and girder ends. Leakage at the joints initiates concrete spalling/deterioration of the concrete substructure elements and corrosion of steel bearings and girders due to the presence of chlorides used in road deicing salts during winter storms. These conditions result in substantial maintenance costs to owners. Recent applications of Ultra High Performance Concrete (UHPC) link slabs to eliminate deck joints has proved to be effective in reducing substructure, bearing, and girder end deterioration, increasing deck durability and ride performance, and significantly reducing future maintenance costs. They are also considered a new trend in Accelerated Bridge Construction (ABC) as they reduce construction/repair time resulting in rapid restoration of traffic along major highways. Recently, the Delaware Department of Transportation (DelDOT) has been evaluating the application of UHPC links slabs on its I-95 corridor rehabilitation project located in Wilmington, Delaware. This presentation discusses the implementation of the UHPC material and its structural behavior within the project.

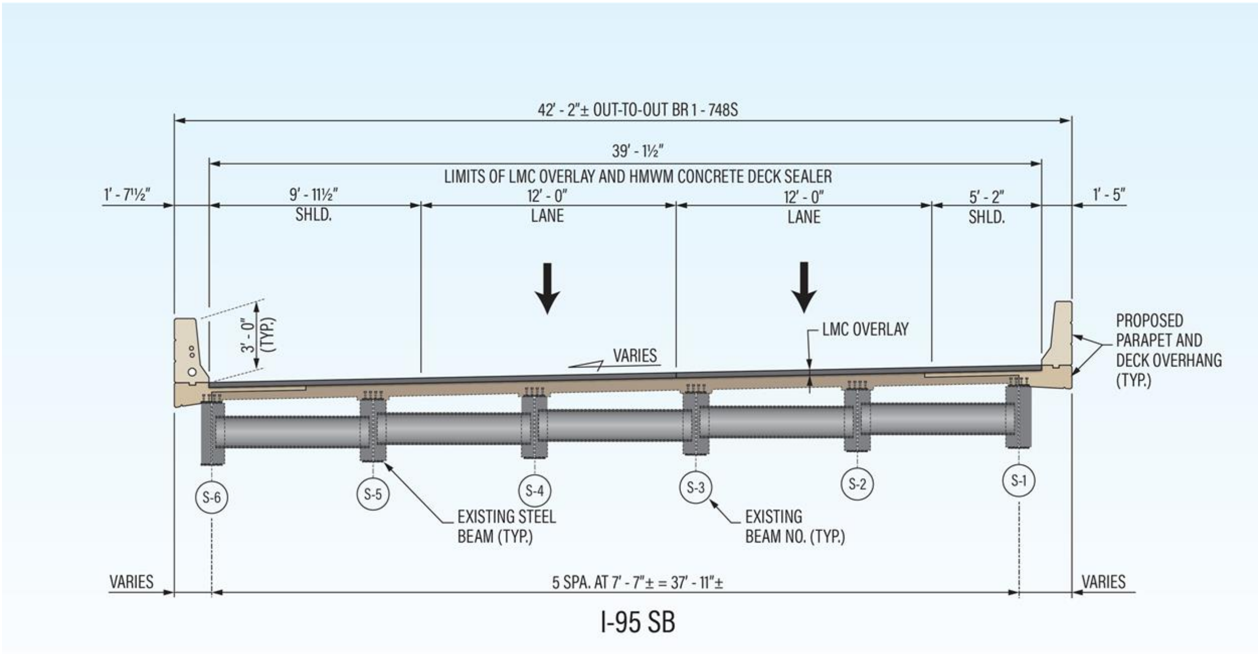
ABSTRACT

The I-95 Wilmington Viaduct in Wilmington, Delaware is a sixty-simple span steel multi-beam bridge scheduled for rehabilitation in 2021. Work will include substructure repair, parapet replacement, deck overlay replacement, and transverse bridge deck joint replacements. Whitman, Requardt and Associates (WRA) is investigating the removal of fifteen (15) failing transverse bridge deck joints via replacement with UHPC link slabs. In addition to the benefits of lower future maintenance, UHPC link slabs will accelerate the construction process by limiting the amount of required deck removal, eliminating the timely installation of a conventional armored joint system, and concrete cure time. In addition, UHPC link slabs will provide an overall cost saving in comparison to a conventional joint replacement. Other advantages of using UHPC link slabs are: eliminating the construction complexities associated with placing an armored strip seal system, extending the service life of the adjacent structural elements as they will be protected from the environment and increasing the long-term durability and performance of those joints located over the piers. Similar applications completed by the New York State Department of Transportation (NYSDOT) suggests that the UHPC material is performing adequately with acceptable crack spacing control to prevent moisture and chloride penetration within the depth of the link slab. The NYSDOT application was based on using the link slab in conjunction with elastomeric expansion bearings at the ends of adjacent spans (i.e., at Exp.-Exp. locations). WRA is exploring the use of the NYSDOT approach to extend the application of UHPC link slabs at superstructure locations with different simple span end conditions supported by steel sliding

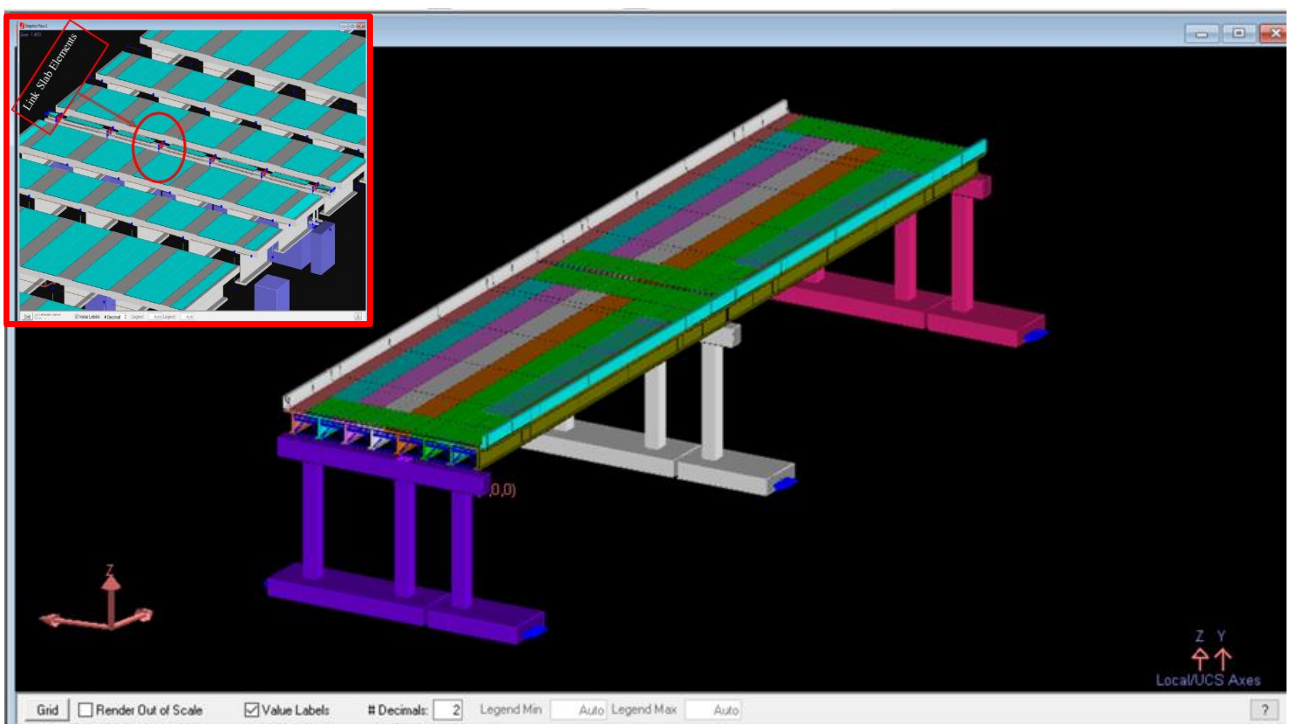
bearings, i.e., Fix-Fix, Exp.-Exp. and/or Fix-Exp. LARSA-4D was used to model the three-dimensional non-linear integrated behavior of the UHPC link slab within the bridge structure. The computer model included the non-linear properties of the UHPC material as well as its cracking and ultimate response. The analysis considered the debonded length of the link slab over the girders and was able to predict the strain level at which the cracks (within the link slab) initiated. Within the model, the non-linear link slab elements were able to depict the load reversal cycles (tension/compression) within the link slab under the application of live loads. It also accommodated any change in the UHPC properties for more general parametric investigations. The model covered the structural response of the UHPC link slab with different support conditions. Results have shown that the UHPC link slabs could be considered for use beyond just the Exp.-Exp. conditions and may extend the use of this detail to more structures. The UHPC link slab proposed by WRA has the potential to accelerate the rehabilitation process, reduce future maintenance costs, and increase structure durability.



The I-95 Wilmington Viaduct



Transverse section at Pier 56S (I-95 Wilmington Viaduct SB)



LARSA 4D model of link slabs along the I-95 Wilmington Viaduct project